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Environment and Packaging
環境と包装

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1. Introduction

My colleague, Dr. Gordon Robertson of Tetra Pak Asia/Pacific, summarizes society's overall approach to the environment as follows:

・ Environmental Issues are Emotional
・ Environmental Solutions are Technical
・ Environmental Decisions are Political
・ Environmental Advantages are Competitive

I would add another two points:

・ Environmental Problems are Complex
・ Environmental Information is Always Inade-Quate

Environmental issues related to packaging are no exception and the debate over packaging tends to be driven by emotion, misconceptions, and local infrastructure related issues. The public debate on environmental issues related to packaging mainly focuses on back end issues which is probably inevitable given the visible nature of packaging in domestic solid waste even though the bulk of environmental impacts related to packaging systems are related to extraction of raw materials, processing of the raw materials, and production of the packaging material, all front end aspects.

I would like to start this presentation by reviewing the environmental, resource, and energy framework that Japan, packaging, and liquid food packaging in particular exist within. Without understanding this context, it is difficult to evaluate the relationship of the environmental issues to the overall environmental issues facing Japan.

2. Japan and the Environment

Japan has an interesting image in other countries regarding the environment Environmental professionals in many countries are aware of Japan's unparalleled achievements1 in improvement of air quality including leading development of low emission automobiles, clean fossil fuel fired power plants, and creation of a superb infrastructure for managing municipal solid waste. This is contrasted by the sharp attacks on Japan for its scientific whaling program and attempts to end the ban on commercial whaling, its role as the world's largest importer of tropical hardwoods, and reactive rather than proactive, approach to

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environmental issues in general. One major example is the initial strong resistance during the negotiation of the Montreal Protocol to the phaseout of CFCs.

So, what is Japan's real status in relation to the environment? How does Japan compare to other advanced industrial countries?

Japanese think of Japan as being a small country. In terms of land area, while Japan may be small compared to the United States, Russia, or China, its land area is larger than most of the countries hi Europe including Italy, Germany, and the United Kingdom.

Japan has the second largest population of the OECD member countries and if it were a member of the European Union, Japanese would be language spoken by the largest number of EU citizens, ahead of English, French, and German.

Of the OECD member nations, Japan ranks 2nd for total CO_2 emissions, is the second largest consumer of fossil fuel, largest producer of steel, second largest producer and consumer of paper, and second largest producer of municipal and industrial solid waste[1),2)].

Environmental data contained in the latest OECD Environment Compendium was used by the UK newspaper, The Independent, and a think tank to rank the G7 nations in “The Green League Table” as shown above. Japan ranked first with 71.5 out of 100 with the United States at the bottom of heap with a score of 34.5. While not a perfect evaluation, the results show that the investments in environmental protection made over the past two decades by Japan have had some impact especially in regard to air quality. Also, the score of 71.5 indicates that there are some areas with room for improvement.

Table 1 OECD/G7 Green League Tables[6)]

	CO_2 tons/capita	SOx kg/capita	Nox kg/capita	Sewage Treatment % Covered	Municipal Solid Waste kg/capita	Energy Use TOE/ $1000 GDP	Overall Score
Best	2.31 tons	7.0 kg	3.0 kg	98 %	257 kg	0.21	
Worst	19.8 tons	122 kg	74 kg	1 %	776 kg	0.5	
Japan	63.3	100	89.5	42.4	70.3	91.7	71.5
Italy	71.9	76.3	55.8	61.6	82.5	100	67.2
UK	53.4	52.5	37.3	88.7	82.5	71.8	63.6
France	72.8	86.2	67.2	69.4	86.3	76.6	62.5
Germany	43.6	44.2	47.4	87.1	82.1	78. 5	59.6
Canada	19.8	0.0	4.3	71.2	33.7	0.0	37.2
USA	0.0	35.0	0.3	75.3	10.6	26.2	34.5

3. Japan and Resources

Most papers discussing Japan and its economy will include an obligatory comment about Japan being very resource poor. On the other hand, environmental commentators use adjectives like "voracious" and "predatory" in regards to Japan's drive to obtain resources. The following table illustrates Japan's consumption of selected materials and the large share of these resources used relative to Japan's population.

Table 2 Consumption of Materials 1991[7)]

Material	Global Consumption (tons)	Consumption Japan (tons)	Rank (%)
Aluminum	17, 194,000	2,43 1,600	2 (14.1%)
Steel	732 ,002,000	99, 1 49,000	1 (13.5%)
Cadmium	20,200	6,400	1 (31.7%)
Copper	1 0,71 4,000	1 ,61 3,200	2 (15.1%)
Lead	5,342,200	422500	2 (7.9%)
Nickel	882,000	180,100	1 (20.4%)
Tin	218,200	34 ,900	2 (16.0%)
Zinc	6 ,992,800	845,500	2 (12.1%)
Petroleum	3,068,300,00 0	249, 700,000	3(8.1%)

As this table shows, Japan is either the largest or second largest consumer of most of these materials (Japan's rank was raised in a few cases since the former Soviet Union no longer exists). Japan is also the largest or second largest importer of these materials and other materials such as tropical hardwoods.

4. Packaging and Resources

As the Japanese economy as a whole consumes a substantial share of the world's resources, packaging accounts for a significant

Table 3 Material Consumption for Packaging 1992[7),1),9)]

Malerial	Total Use[a] (000 tons)	Packaging Use (000 tons)	% Packaging Use
Paper/Paperboard	27,987	12,017	42.9%
Plastic	12,796	3,570	27.9%
Steel	98,132[b]	2,150	2.2%
Aluminum	2,431	376	15.5%
Glass		2 ,370	
Wood	69,120[c]	1 ,560	2.3%

a. 1991 unless Otherwise Noted
b. 1992
c. Does not include pulp raw materials.

share of the consumption of various materials as the following table shows.

Although a detailed analysis of the resource impacts of these packaging materials is beyond the scope of this presentation, it should be noted that the reserves of the primary raw materials for aluminum, steel, and glass while not renewable are available in quantities that can be considered to be nearly inexhaustible. Some materials used for alloying and coating metal products (e.g. tin) have relatively limited reserves. Although petroleum reserves are limited, use of petroleum and other fossil organic materials for feedstocks for producing plastics are only a few percent of the total consumption of petroleum. In addition, alternative feedstocks for producing plastics are available including biomass based feedstocks. Forest resources, although threatened in many developing countries, with proper management can provide a sustainable yield of fiber and other products as in the case of the managed forests of the industrialized countries of North America and Northern Europe.

Rather than availability of resources, the environmental impacts associated with extraction and processing of the various materials used for packaging will probably be a major constraint on the availability of these materials. Worldwide 24 billion tons of non-fuel minerals are extracted and a total of 28 billion tons of material including overburden are moved to extract the minerals. One copper mine in Papua New Guinea dumped 130,000 tons of waste daily, roughly the same amount as the daily municipal solid waste in Japan, until it was closed by a civil war. It should be noted that copper mining produces more mining waste per ton than iron or aluminum due to its low average grade (0.91%) compared to 40% for iron and 23% for aluminum. It has been estimated that 500,000 hectares (more than the combined area of Tokyo and Kanagawa) are directly impacted by mining activities. In the United States, a number of Superfund Hazardous Waste sites are disposal sites for mining waste including the large Superfund Site located in Montana along 220 km of the Clark River. It has been estimated by a local environmental group that the cleanup of the mine site and disposal sites will cost in excess of $1 billion.

Large amounts of energy are consumed in the extraction and processing of metal ores. Taking aluminum as an example, on a global scale, the aluminum industry is estimated to use 290 billion kwh of electricity for smelting aluminum, more electricity than is consumed on the African continent Taking the energy required for mining and other processing into account, the aluminum industry is estimated to consume about 1% of the world's energy[8)].

Although economic shifts including the rising value of the yen may reduce incentives, the environmental impacts of extracting and processing metals even with a high level of environmental control are such that this provides a major incentive for recycling of metals. The same incentives exist to lesser degrees for glass, paper, and plastics. In the case of paper and plastic, a combination of material recycling and energy recovery is appropriate.

5. Packaging, Solid Waste Management, and Recycling

The solid waste management problems of local governments in Japan are real and pressing and used packaging is certainly a visible part of the problem. The share of packaging material in municipal solid waste has been estimated to be about 30% which seems to be typical for major developed nations. Although it is a major cost factor, management of municipal solid waste is not an environmental problem but an infrastructure problem. Although Japan is currently a world leader in municipal infrastructure investments, including municipal solid waste management facilities, it is also obvious that no reasonable investment program could have kept pace with the explosive growth in solid waste during the era of the bubble economy during the late 1980's.

Given these circumstances, it's not surprising that local governments are emphasizing recycling as a major part of their solid waste management programs. In particular, collection programs being conducted by local governments emphasize the collection of beverage containers (glass bottles, steel, and aluminum cans) and paper. Municipal governments account for over 95% of the steel cans collected and a high proportion of the aluminum cans collected. The total consumption of beverage containers in Japan is equivalent to less than 10% of the municipal solid waste stream and less than 5% if glass bottles are not considered. Given that the recycling rates for glass bottles and metal cans are greater than 50%, further increases in collection will not have a major impact on the success or failure of solid waste minimization programs. Paper has an overall recycling rate over 50% and the prospects for major increases in use of waste paper as a feedstock are limited as many types of paper are approaching current technical limits for recycled fiber content

Japan has a long history of recycling and even prior to the current re-emphasis on recycling has had relatively high rates of recycling for many materials. The recycling system until recently was driven primarily by the raw material needs of various production processes, what can be called demand pulled recycling. Recycling programs like DSD in Germany, municipal collection programs in North America, and the current efforts by local governments can be called supply pushed recycling. Supply pushed recycling efforts often encounter major difficulties in regards to finding outlets for the materials collected particularly during the early years of such programs.

Taking DSD as an example, 1993 was a successful year for collection and DSD collected 4.6 million tons of packaging material and arranged.for recycling of 85% or 3.9 million tons (equivalent to a 13% diversion of solid waste from municipal waste management). DSD was less successful at controlling costs and collecting the fees for use of the Green Dot and accumulated debts of about one billion DM. It required major refunding including conversion of debts into loans from waste haulers and other vendors. DSD was actually too successful at collecting many materials and succeeded in overwhelming recycling capacity in Germany and other countries. Exports of materials for recycling included 1.3 million tons of paper and 170,000 tons of plastic (60% of the amount collected) to Eastern Europe and Asia. Some of this plastic along with shipments from other countries were the subject of a request for return to the country of origin by Indonesia due to contamination, lack of proper sorting, and other factors that rendered the material difficult to recycle.

Table 4 DSD Collection by Material in 1993[2)]

Material	tons
Glass	2 ,460,000
Paper/ Paperboard	1,160,000
Paper Beverage Cartons	52,000
Tinplate	250,000
Aluminum	9,000
Plastics	280,000

The projected cost operating DSD in 1994 is 3.2 billion DM or 40 DM (¥2,400) per capita. Along with the cost of the system, it remains to be seen whether Germany will resolve other problems related to the program although a rapid expansion in recycling capacity for plastic is being implemented by major petrochemical companies. A number of revisions to the packaging ordinance are being considered including permitting the use of incineration with energy recovery for materials collected in excess of targets and changes in deadlines for achieving targets. The German experiment will continue to be of great interest and it will be important to receive the right lessons from this experience.

6. Life Cycle Analysis and Packaging

Conceptually life cycle analysis is a straight forward exercise, adding up the various inputs and outputs for a given system. The actual execution is relatively difficult, time consuming, and the accuracy of the results limited by the quality of the input data. The Coca-Cola company sponsored one of the first life cycle analysis studies of beverage containers in 1969. Since then Life Cycle Analysis has become wide used, especially in the last five years and a number of life cycle analysis studies of packaging are being conducted in Japan by packaging makers such as Toyo Seikan and Nihon Tetra Pak, industry groups such Chemical Economy Research Institute and Plastic Waste Management Institute, and packaging users like the Japanese Consumers* Cooperative Union.

Most of the studies conducted thus far in Japan have focused on the life cycle inventory or compilation of the various inputs and outputs of a given system. This stage, while time consuming and costly, is straightforward although there a number of approaches for compiling and expressing an inventory. Also, inventory compilation is also hampered by the difficulty of access to necessary data.

The next stage, life cycle assessment, is an area where much more work is required and there seem to be about as many ways to conduct life cycle assessments as there are workers in the field. Much of the problem stems from the fact that for many environmental problems such as acid rain or toxic substances, the dose response relationship is either not well understood or varies markedly with the location, season, and other environmental factors. The assessment stage is essential taking the environmental outputs from systems and converting them into impact functions. These impact functions are then used as a basis for assessing the overall environmental impact of a given product or system. A variety of approaches have been used to compile the results of life cycle inventories and assessments including assignment and adding up Ecopoints, conversion of health effect impacts into monetary value, and development of a range of damage functions based on various criteria including local environmental standards.

The best use of a life cycle inventory or assessment is for identifying and evaluating measures for improving the environmental performance of a product Life cycle analysis is less useful for deciding between different types of packaging because systems are not always functionally equivalent. Also, factors other than the types of parameters that can be handled by life cycle analysis such as health and safety regulations, suitability for a given distribution route, and consumer convenience weigh heavily in the selection of packaging.

Some basic points that can be made based on LCA inventories are as follows:

- ・E The bulk of energy consumption and environmental impact for most one way packaging systems occurs during the production of the raw materials with transportation being the next largest item.
- ・E Energy consumption is proportional to the amount of material used.
- ・E Emissions of sulfur oxides and other fossil related air pollutants are closely linked to energy consumption.

These points illustrate the importance of source reduction in reducing the environmental burden of packaging.

To illustrate one practical application for LCA, I would like to briefly discuss the results of a study which will be presented in more detail by the project team during the last session of this Meeting. Last year Nihon Tetra Pak sponsored an analysis of the recycling of milk cartons versus handling by municipal solid waste management

One of the key points of the milk carton recycling system in Japan is the requirement that cartons be clean and dry. This is primarily due to the collection route which involves handling by waste paper dealers who are not equipped to handle wet and dirty materials. Based on a survey of individuals involved in carton recycling, it was estimated that the amount of water used to wash a carton was greater than the amount of water used to produce the raw materials in a carton.

Two major cases were examined. The recycling case with production of toilet paper from collected,consumer waste cartons. The incineration case with cartons being incinerated with energy recovery and with production of toilet paper from virgin materials included to provide the same endpoint Energy consumption and water consumption were less for the incineration case while other environmental parameters evaluated were better for the recycling case. If the production of toilet paper from virgin material is not included in the incineration case, most of the environmental parameters evaluated would be better for the incineration case[3).

Although the results did not point out a clear "winner" from an environmental standpoint, one clear recommendation did emerge for reducing the environmental burden of recycling. Care needs to be take when rinsing cartons to reduce the water used. The water used for rinsing cartons even in the worst case is a trivial proportion of household water consumption but use of 2 to 3 liters of water to rinse a carton is significant in the life cycle of a package made from about 30 grams of material.

7. Closing Comments

In discussing packaging and the environment, it is difficult to discuss these issues without considering Japan's overall policies and situation regarding environment, resources, energy and solid waste management As noted earlier in the presentation, for most of the major packaging materials used in Japan, the use of those materials for packaging are not dominant factors in the use of those resource bases. Japan and other industrialized countries are in the process of groping towards new policies that will reduce the overall impact of the developed world on global resources and the environment Packaging will definitely have a contribution to make in the implementation of these new policies.

Although journalists, politicians, environmentalists, and public relations specialists focus on key catch phrases such as “Building the Recycling Society”, the real world is complicated and approaches akin to the free size concept for women's clothing which results in garments that don't fit many women will not help us to meet real world environmental objectives. Unfortunately recycling to many people has become an objective rather than a means to a end and this is responsible for many of the distortions that we see hi public perception and policy today.

Although not as pleasing to the ear as “Building the Recycling Society”, our real goal as a society and industry is “Achieving a Sustainable Resource and Energy Conserving Society with Low Environmental Impact”. For the packaging industry, our contribution must be to provide packaging that meets packaging performance needs while minimizing resource and energy consumption. We have a variety of means to achieve these objectives and the mix of approaches that is best for Japan is likely to be different from the mix used in the United States or Europe. Source reduction, reusable packaging, recycling, use of renewable resources and energy, and a solid waste management system that maximizes energy recovery will all play important roles in reducing the net environmental burden of packaging and the economy as a whole.

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